Section 5
Noise

RSG INC.
RESOURCE SYSTEMS GROUP, INC.

MEMORANDUM

To:	Andy Novey
From:	Isaac Old
Subject:	Addendum: Siemens SWT 3.0-113 Sound Modeling Results for Canton Mountain Wind
Date:	May 18, 2012

NOTE: This memo is an addendum to the RSG report "Noise Modeling Study for Canton Wind Farm: Canton, Maine," dated December 2011.

Patriot Renewables requested that RSG perform sound propagation modeling for the Canton Mountain Wind Project, using eight Siemens SWT 3.0-113 turbines in the locations previously modeled using Gamesa G90 and GE 2.75-100 and 2.75-103 wind turbines. This memo includes a description of the acoustical characteristics and sound propagation modeling results using the Siemens wind turbine.

SIEMENS SWT 3.0-113 ACOUSTICAL EMISSIONS

SOUND POWER

The project proposes to use eight Siemens SWT 3.0-113 3.0 MW wind turbines with a hub height of 90 meters.

Sound emissions from a wind turbine are measured as *sound power*. The sound power level from a Siemens SWT 3.0-113 is 106 ± 1.5 dBA with wind speeds greater than 7 m/s (10-meter anemometer height). The modeled level in this report is 109.5 dBA, as it includes the manufacturer uncertainty factor of 1.5 dB plus a 2 dB modeling uncertainty factor. The octave band sound power levels are shown in Table 1. Compared to the GE 2.75-103, the Siemens turbine emits more high frequency sound and less low frequency sound. Since high frequency sound is attenuated more rapidly by the atmosphere than low frequency sound, sound levels from the Siemens turbine will be slightly higher close to the turbines, but lower further away, as compared with the GE and Gamesa turbines.

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Table 1: Spectral Sound Power Levels (dBA)

Turbine Model and 10-m Height Wind Speed	Nominal Sound Power (dBA)	1/1 Octave Band Center Frequency								
		31.5 Hz	*63 Hz*	*125 Hz*	*250 Hz*	*500 Hz*	*1 kHz*	*2 kHz*	*4 kHz*	*8 kHz*
Siemens SWT 3.0-113 for 8 m/s to cutout	106	n/a	84	89	99	100	100	90	92	75
GE 2.75-103 for 7 m/s to cutout	105	83	92	96	98	98	99	96	88	71

TONALITY

Because the Siemens SWT 3.0-113 is a new model, 1/3 octave band data is not yet available. However, Siemens has guaranteed that its turbine emits no tonal sound according to the Maine DEP definition.

MODELING

MODELING PARAMETERS

Modeling parameters for the Siemens turbine configuration were the same as with the other turbine configurations except where manufacturer specifications differed. That is, we modeled sound propagation in accordance with ISO 9613-2 for omnidirectional wind, using spectral ground attenuation and a ground absorption factor of 0.5 (to represent mixed ground). A 1.5 dB manufacturer's confidence interval and a 2 dB modeling uncertainty margin were added to the sound power level of the wind turbines (See Table A1).

A 15-meter by 15-meter grid of receivers was set up in the model covering 32 square miles around the site. This accounts for a total of about 373,000 modeled receivers. A receiver is a point above the ground at which the computer model calculates a sound level. Separate discrete receivers were added to the model in addition to the grid to represent the 30 residences and camps located nearest to the proposed wind turbines and 30 residences and camps within 1 mile of the substation. Three receivers were placed to represent the worst case locations within a 500-foot radius of the three closest non-participating homes near the project. Grid receivers were modeled at a height of 1.5 meters, discrete receivers representing homes were modeled at a height of 4.0 meters, and discrete receivers representing other locations were modeled at a height of 1.5 meters. Given its extent, property boundaries were modeled using the receiver grid rather than discrete points.

The Siemens SWT 3.0-113 turbines produce a maximum power output of 3.0 MW and have 113-meter diameter rotors, which are mounted on 90-meter towers. In addition to the wind turbines, two 34.5/115 kV transformers were modeled. One transformer will support the proposed Canton Mountain Wind project and the other will support the already-permitted Saddleback Ridge Wind project.

RESULTS

Results from the modeling are shown graphically in Figure 1. Discrete receiver results are shown in Table A2. The highest modeled sound levels are shown in Table 2. Maine DEP noise level limits are met in all situations.

Table 2: Highest Modeled Sound Levels Compared to Maine DEP Noise Level Limits

Location	Modeled Sound Level	Noise Standard
Nearest residence	43 dBA	55 dBA (day)/45 dBA (night)
500 feet from nearest residence[1]	43 dBA	45 dBA (night)
Property boundary of nearest residence[2]	51 dBA	55 dBA (night)
Property boundary of project	51 dBA	75 dBA

INFRASOUND AND LOW FREQUENCY SOUND RESULTS

The Maine DEP does not have a separate standard for infrasound or low frequency sound.

Criteria for noise induced building vibration at the interior of buildings can be found in ANSI S12.2-2008, "Criteria for evaluating room noise." The criteria for "moderately perceptible vibration and rattle likely" is 65 dB at 16 and 31.5 Hz, and 70 dB at 63 Hz octave bands.

To assess whether low frequency sound may have the potential to cause interior low-frequency noise issues, we modeled the 63 Hz octave band. Of all the non-participating residences evaluated, the highest sound level outside at 63 Hz is 52 dBA. This modeled sound level is below the noise-induced vibration threshold. The 16 Hz and 31.5 Hz octave band sound power is not available for this turbine. However, most wind turbines have a flat spectrum in this range, thus, it is expected that exterior sound levels at 16 Hz and 31.5 Hz will similarly be below the ANSI S12.2 criteria.

Modeling at infrasound frequencies was not conducted, as modern wind turbines typically do not generate problematic infrasound levels.

CONCLUSIONS

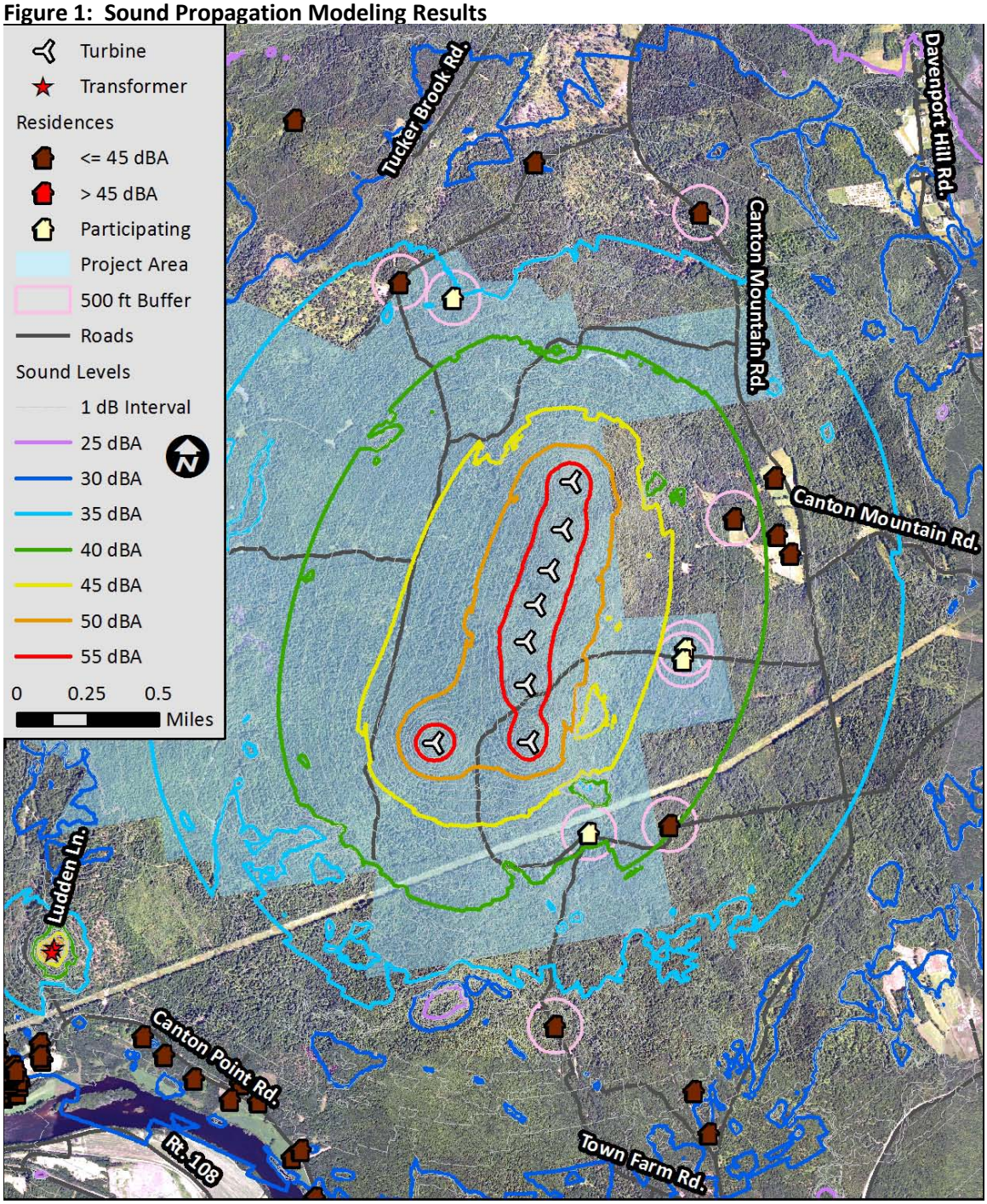
Sound propagation modeling was performed for the proposed Canton Mountain Wind Project, using eight Siemens SWT 3.0-113 turbines, in the same locations previously modeled with Gamesa G90 and GE 2.75-100 and 2.75-103 wind turbines. Results are as follows:

[1] A map of surveyed property boundaries outside of the Project is not available. This it is assumed that the full 500 foot buffer around each residence is owned by that residence and is a protected location.

[2] A map of surveyed property boundaries is not available outside of the Project parcel. Therefore, it is assumed that all areas outside of the project are protected locations.

- At residential protected locations, a noise standard of 55 dBA during the day is applied. At night, a noise level of 45 dBA must be met within 500 feet of any residence (or its property line, whichever is closer), according to Maine DEP Chapter 375.10 regulations. At all other locations outside of the project property, a standard of 75 dBA must be met.
- The Siemens SWT 3.0-113 turbine has a sound power of 106 ± 1.5 dBA. Turbines were modeled with a ground factor of G = 0.5 and 3.5 dB added to account for uncertainty in sound power and modeling. The total modeled sound power was 109.5 dBA for each wind turbine.
- Siemens has guaranteed that the SWT 3.0-113 wind turbine will not emit tonal sound according to the Maine DEP definition.
- The highest sound level modeled at and within 500 feet of a non-participating residence was 43 dBA (receivers 9 and 9B), complying with the Maine DEP nighttime standard for residential protected locations.
- The highest sound level modeled outside of the 500 foot buffers is 51 dBA, complying with the Maine DEP daytime standard for protected locations and all other locations.
- The modeled levels of low frequency sound will not create perceptible building vibration.
- With no additional mitigation, the modeled results described in this report for the Canton Mountain Wind project are within the noise standards set out by the Maine Department of Environmental Protection.

Figure 1: Sound Propagation Modeling Results



APPENDIX A: SOURCE AND RECEIVER INFORMATION

Figure A1: Receiver Locations

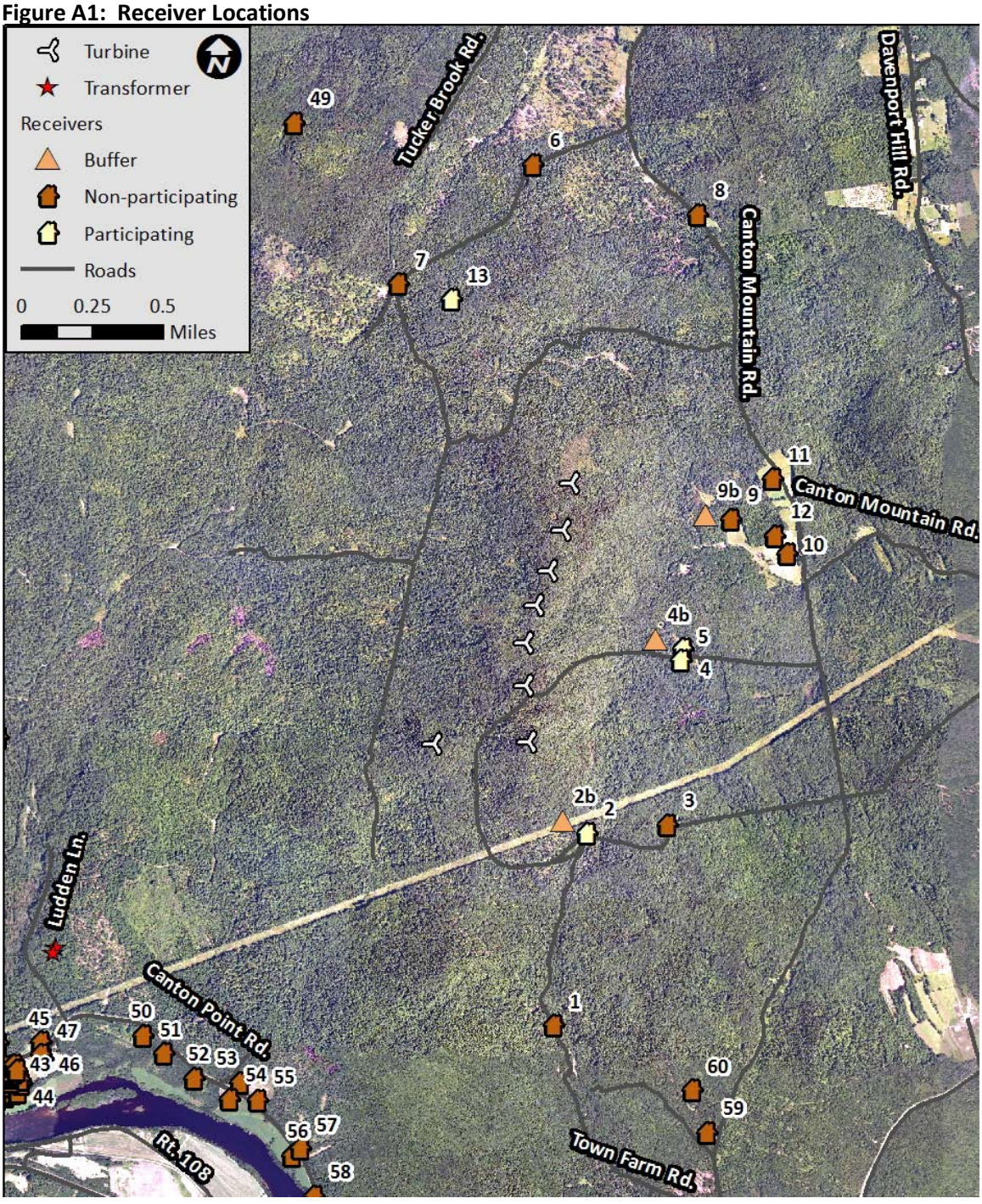


Table A1: Source Information

Source ID	Modeled Sound Power (dBA)	Nominal Turbine Sound Power (dB)	Source Height (m)	Coordinates at Source Height (UTM NAD83 Z19N)		
				X (m)	Y (m)	Z (m)
T1	109.5	106	90	396625	4930556	545
T2	109.5	106	90	396576	4930287	551
T3	109.5	106	90	396500	4930057	555
T4	109.5	106	90	396425	4929860	555
T5	109.5	106	90	396364	4929651	544
T6	109.5	106	90	396365	4929406	550
T7	109.5	106	90	396382	4929083	560
T8	109.5	106	90	395844	4929075	495
Transformer - Canton Mountain Wind Project	93	93	3	393699	4927916	168
Transformer - Saddleback Ridge Wind Project	93	93	3	393683	4927887	166

Table 3: Discrete Receiver Results

Receiver ID	Status	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates at Source Height (UTM NAD83 Z19N)		
				X (m)	Y (m)	Z (m)
1	Non-participating	35	4	396535	4927470	192
2	Participating	42	4	396726	4928565	290
3	Non-participating	42	4	397183	4928611	279
4	Participating	45	4	397273	4929612	271
5	Participating	45	4	397261	4929546	270
6	Non-participating	32	4	396419	4932369	280
7	Non-participating	38	4	395653	4931689	350
8	Non-participating	36	4	397358	4932082	279
9	Non-participating	43	4	397547	4930349	241
10	Non-participating	40	4	397867	4930150	226
11	Non-participating	41	4	397782	4930579	238
12	Non-participating	41	4	397793	4930254	230
13	Participating	38	4	395957	4931599	364
14	Non-participating	21	4	392501	4926924	146
16	Non-participating	28	4	392817	4927103	143
17	Non-participating	27	4	392918	4927107	141
18	Non-participating	29	4	393117	4927231	143
19	Non-participating	30	4	393238	4927258	139
20	Non-participating	29	4	393311	4927258	139
21	Non-participating	32	4	393377	4927368	144
22	Non-participating	31	4	393379	4927211	140
23	Non-participating	30	4	393338	4927199	139
24	Non-participating	31	4	393343	4927181	139
25	Non-participating	31	4	393381	4927185	139
26	Non-participating	31	4	393350	4927160	139
27	Non-participating	31	4	393397	4927143	139
28	Non-participating	31	4	393352	4927132	139
29	Non-participating	31	4	393418	4927105	137
30	Non-participating	30	4	393357	4927069	136

Receiver ID	Status	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates at Source Height (UTM NAD83 Z19N)		
				X (m)	Y (m)	Z (m)
31	Non-participating	31	4	393414	4927068	135
32	Non-participating	30	4	393366	4927048	134
33	Non-participating	31	4	393455	4927087	135
34	Non-participating	31	4	393449	4927126	137
35	Non-participating	30	4	393487	4927093	133
36	Non-participating	31	4	393503	4927139	136
37	Non-participating	31	4	393496	4927162	137
38	Non-participating	31	4	393446	4927149	138
39	Non-participating	31	4	393442	4927173	139
40	Non-participating	31	4	393432	4927191	139
41	Non-participating	31	4	393421	4927210	140
42	Non-participating	32	4	393411	4927239	141
43	Non-participating	32	4	393464	4927244	139
44	Non-participating	32	4	393479	4927218	139
45	Non-participating	32	4	393615	4927374	139
46	Non-participating	32	4	393630	4927281	137
47	Non-participating	32	4	393618	4927302	138
48	Non-participating	32	4	393376	4929110	159
49	Non-participating	26	4	395060	4932606	309
50	Non-participating	33	4	394198	4927414	131
51	Non-participating	32	4	394320	4927308	134
52	Non-participating	32	4	394490	4927171	134
53	Non-participating	32	4	394750	4927147	128
54	Non-participating	32	4	394693	4927051	126
55	Non-participating	32	4	394853	4927042	129
56	Non-participating	32	4	395044	4926729	126
57	Non-participating	32	4	395093	4926769	129
58	Non-participating	30	4	395172	4926499	127
59	Non-participating	32	4	397407	4926861	163
60	Non-participating	33	4	397324	4927102	192
2b	Buffer	43	1.5	396587	4928636	334

Receiver ID	Status	Sound Pressure Level (dBA)	Relative Height (m)	Coordinates at Source Height (UTM NAD83 Z19N)		
				X (m)	Y (m)	Z (m)
4b	Buffer	45	1.5	397112	4929664	280
9b	Buffer	43	1.5	397396	4930372	247